TSD Automation Workshop Initiative Update

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12/17/2020

Initiative Scope

- Develop a Supply and Competency in automation tools for various applications in the target systems
- Procure devices/equipment and set up test benches
- Build skills and experiences for operating the future Remote Handling Automation Lab to be constructed in TSIB
- Involves voluntary services and team activities *outside* of normal job assignments, utilizing individual's strengths and interests

Resources/Support:

- AD – Robotics Initiative led by Mayling
- TSD Management – Training (Python, Sharepoint)
- Fermilab Coding Club – Programming Assistance

Update Overview

- Mu2e Remote Handling Machines
- Automation Workshop
- AD Robotics Activities
- UIC Senior Robotics Project
  - Radiation mapping drone
  - 3D visualization
- Cutting Edge Technology Investigation

Mu2e Remote Handling Machines – Mike Campbell

- Objectives:
  - complete the wiring and assembly of the remote handling machines so that performance testing can commence.
  - prepare for a Mu2e CRR on the remote handling and demonstrate progress against the Mu2e project schedule.
  - develop expertise in AD/TSD to be able to understand and modify the PLC program so that Dave Peterson in not the only person knowledgeable and able to make changes as needed based on the testing results.

Users:

- Dave Pushka
- Mike Campbell
- Keith Anderson
- Dave Peterson
- George Lolov

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Mu2e Target Remote Handler EDIT LINKS Search this site

Mu2e Target Remote Handler

Mu2e Target Remote Handler
Remore Handling Machines
PLC System
PLC System Test Setup
Documents
Mu2e TSD Home
EDIT LINKS

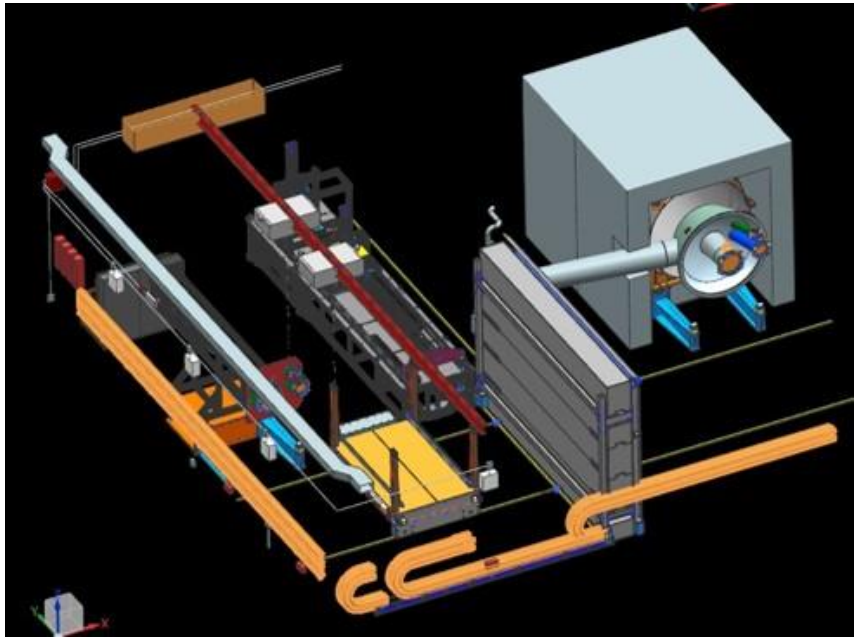
Objectives of the Mu2e Remote handling Series of meeting starting Fall 2020:

1) complete the wiring and assembly of the remote handling machines so that performance testing can commence.

2) prepare for a Mu2e CRR on the remote handling and demonstrate progress against the Mu2e project schedule.

3) develop expertise in AD/TSD to be able to understand and modify the PLC program so that Dave Peterson in not the only person knowlegable and able to make changes as needed based on the testing results.

Meeting Agenda & Progress Report	Meeting minutes / Action Plans, Dave Pushka
Nov 20, 2020, George Lolov I went to Mi-8 today to grab a feedback cable from Keith from one of the motors that have been already installed on the target handler (it was one of the belt drive motors). This feedback cable had a model # of VF-DA0474N-12-0 (the other belt drive motor that was plugged into a Kollmorgen drive had a model # of VF-RA2474N-03-0). I have attached the data sheets for both styles of cable. The RA style of cable is for resolver type feedback, the DA style cable is for SFD style. I believe all of the motors that were ordered have resolver type feedback (correct me if I'm wrong). When I used the DA style of feedback cable for my test	• Keith will need to remove all SFD-style cables that are connected to target handler/window machine motors at Mi-8 • Resolver style cables will need to be ordered for those motors • Keith will install new resolver cables to motors



Mu2e Remote Handling Machines

- Final mechanical build
- Final wiring of both machines
- Wiring of main panel and operator workstation
- Additional motion controls programming

Safety in robots: Mu2e's automated handler

September 10, 2020 | Daniel Garisto and Catherine Steffel

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Every target reaches the end of its life. Particle beam targets, that is.

And while humans perform much of the work in Fermilab's Mu2e experiment, a few tasks, such as target removal, disposal and replacement, are automated and left to machines.

Finding a needle

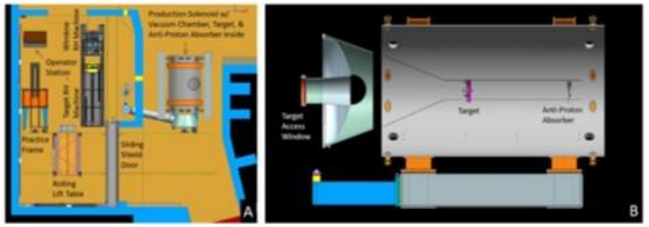
Muons, subatomic particles closely related to electrons, frequently change into electrons by emitting two neutrinos. The discovery of a muon changing directly into an electron *without* the emission of neutrinos is something big. So big that scientists would have to amend the current book on particle physics to explain the phenomenon.

It's exactly this game-changing behavior — the neutrinoless transformation of a muon into an electron — that Mu2e scientists are looking for.

Fermilab engineer Mike Campbell handles the target for the Mu2e experiment. Photo: Ryan Postel, Fermilab

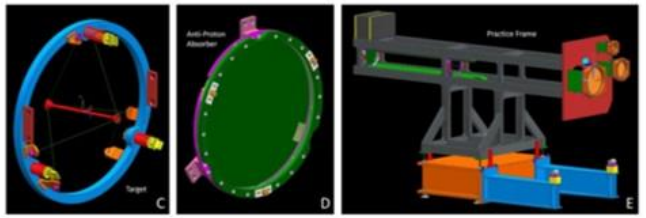
Syatem Layout

The Production Target Remote Handling system for Mu2e primarily consists of 2 robotic machines that travel from a side room into the target hall on floor rails. The machines are able to autonomously remove and replace the target access window, the target assembly, and the anti-proton absorber from the production solenoid. The spent components are placed into radioactive storage casks. Figure A shows the overall system layout. Figure B is a cutaway view of the production solenoid showing where the target access window, target, and anti-proton absorber are all located inside.



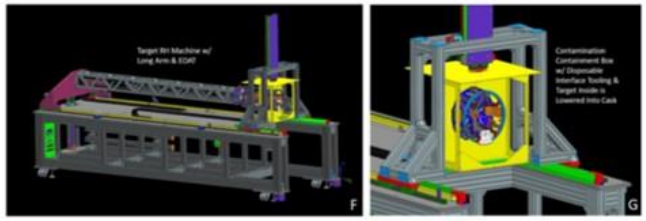
Mu2e Target, Anti-Proton Absorber, & Practice Frame

Figure C is an early version of the production target showing the 3X spring-loaded push/turn mounting latches and 2X gripper handles on the outer ring. Figure D is the anti-proton absorber showing its' 3X mounting features to the stationary ring behind, the 3X gripper handles, and the solid .010" thick AL center panel. Figure E is the "practice frame", which is a dimensional equivalent of the production solenoid with the same center bore and mounting features/locations for the 3 windows, target, and anti-proton absorber.



Target Handling Machine

Figure F shows the target remote handling machine with its' long arm to reach deep into the center bore of the production solenoid to remove/install the target. The mu2e target is planned to be replaced once per year. The anti-proton absorber is also replaceable using a telescoping inner arm to gain the additional reach. Figure G shows the "contamination containment" box. This box holds the spent target and its' disposable interface tooling after they are removed from the solenoid bore. Once these items are in the box, the box is lowered into the waiting cask - which is to be located in the square opening in the tabletop directly below the



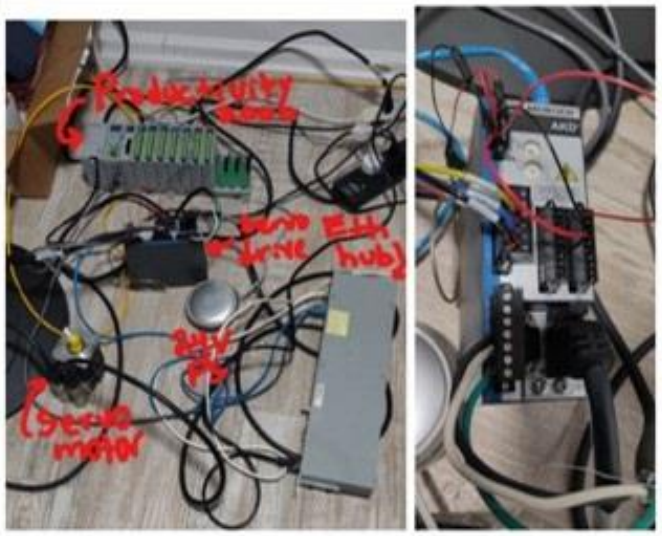
Mu2e Remote Handling Machines– George Lolov

- Testing the Mu2e Remote Handling PLC System with a Servo Motor Test Setup

PLC System Test Setup

Testing the Mu2e Remote Handling PLC System with a Servo Motor Test Setup George Lolov 11/25/20:

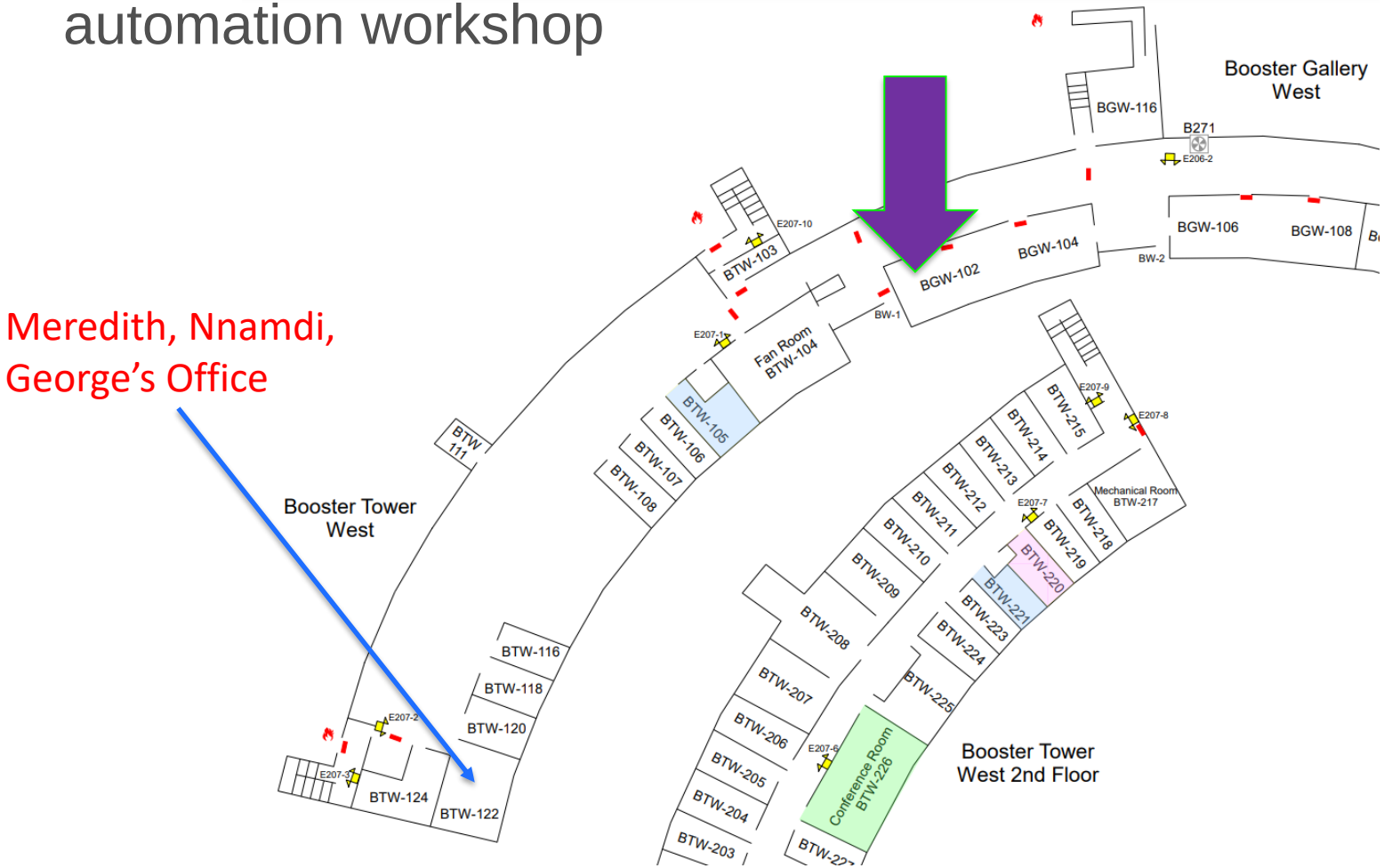
Component Diagram



Kollmorgen Servo Drive Wiring Diagram	AKD Quick Start Manual
Productivity2000 Software	Productivity Suite
Kollmorgen Software	Kollmorgen Workbench
Automation Direct's PLC Training Videos	Training Videos

Automation Workshop

- Booster Gallery West – 102 will be converted into an automation workshop



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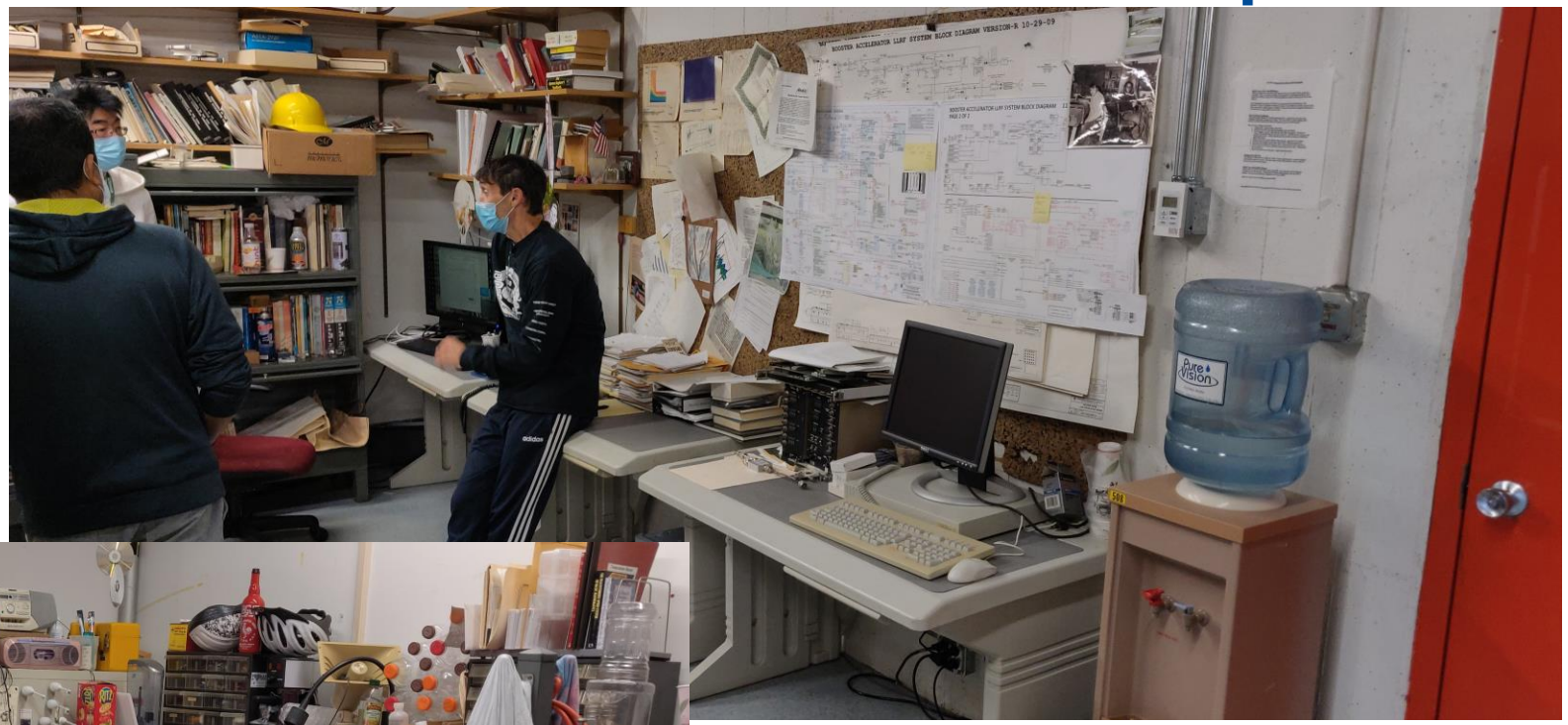
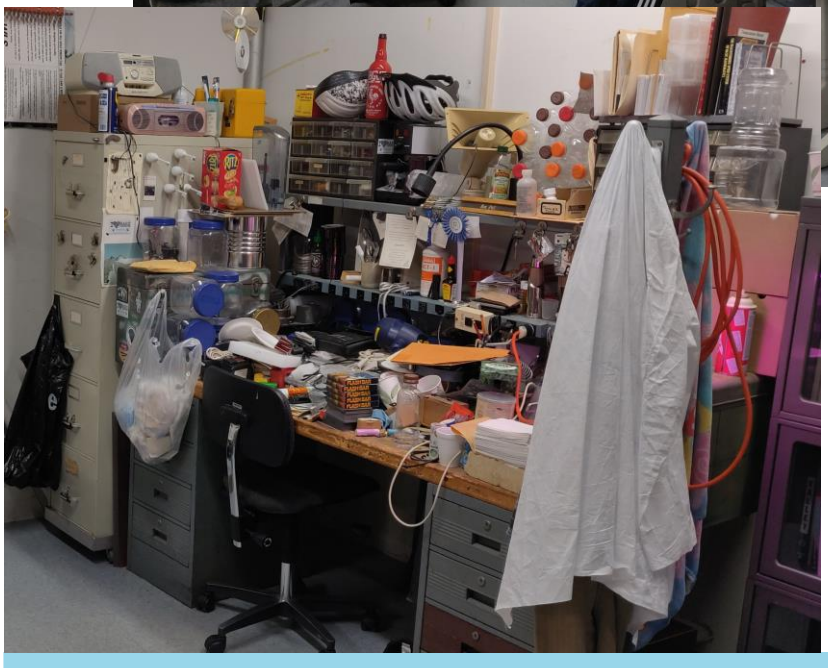
Previous Owners in Process of Cleanup…





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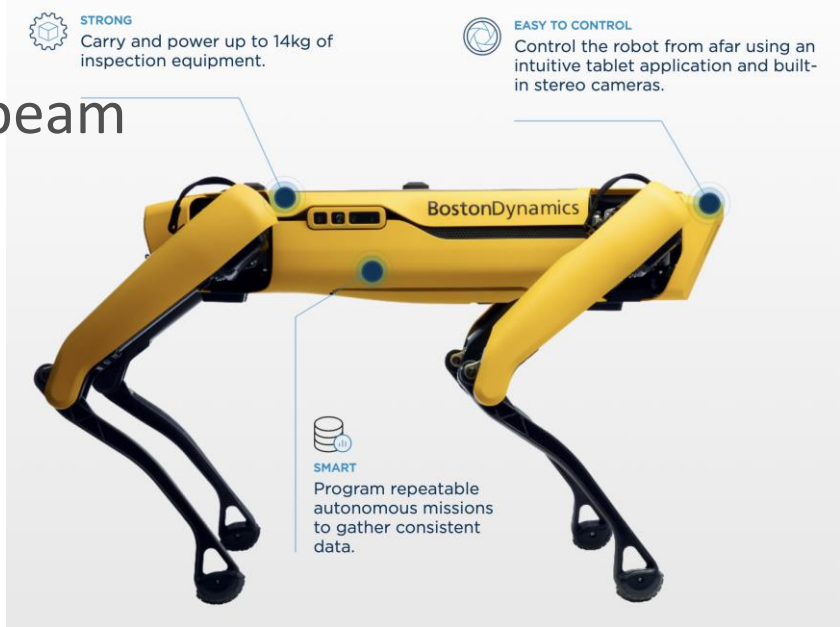
Resource: AD Robotics Activities

- AD has committed to placing a req for a Boston Dynamics SPOT robot
  - Initial use cases will be:
    - Camera rover with ability to climb stairs (search + secure, inspections)
    - Testbed for 5G capabilities in beam tunnels



- Potential NASA collaboration for remote handling prototypes

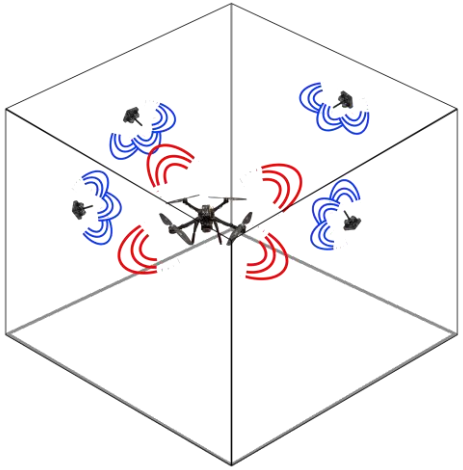
UIC Senior Student Robotics Project

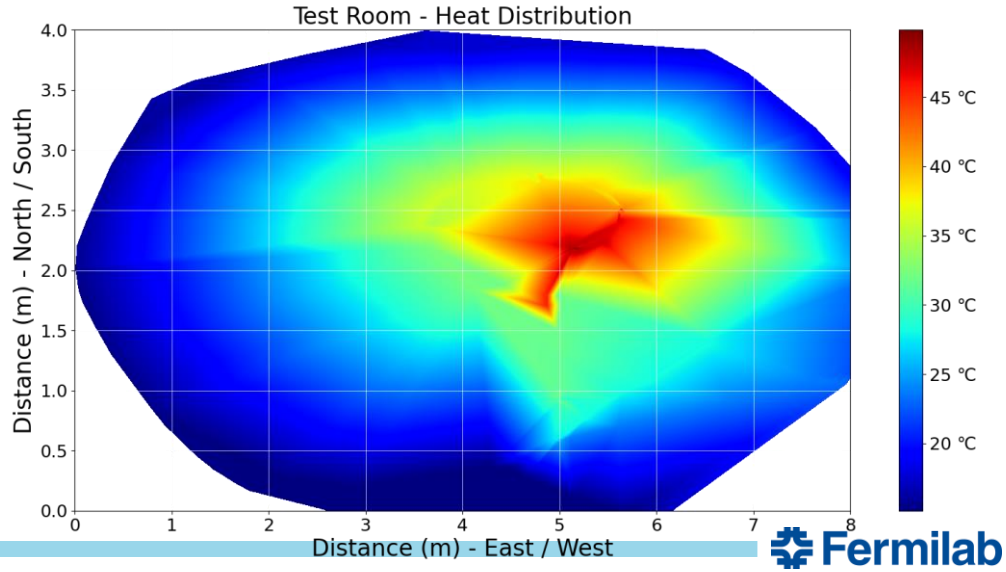
Led by Katsuya Yonehara

- Goal is to create a unique and cheap robot for accelerator facility with senior engineering students
- Two senior student projects proposed
  - Radiation mapping drone
  - 3D Visualization processor for accelerator facility
- $4,000 from HPT R&D + $4,000 from US-JP collaboration in FY21

Radiation Mapping Indoor Drone

- Positioned by using a beacon, no GPS needed
- Test flight done: Make a 3D temperature map by using a heat sensor
- Next step: Install LiDAR and portable rad sensor





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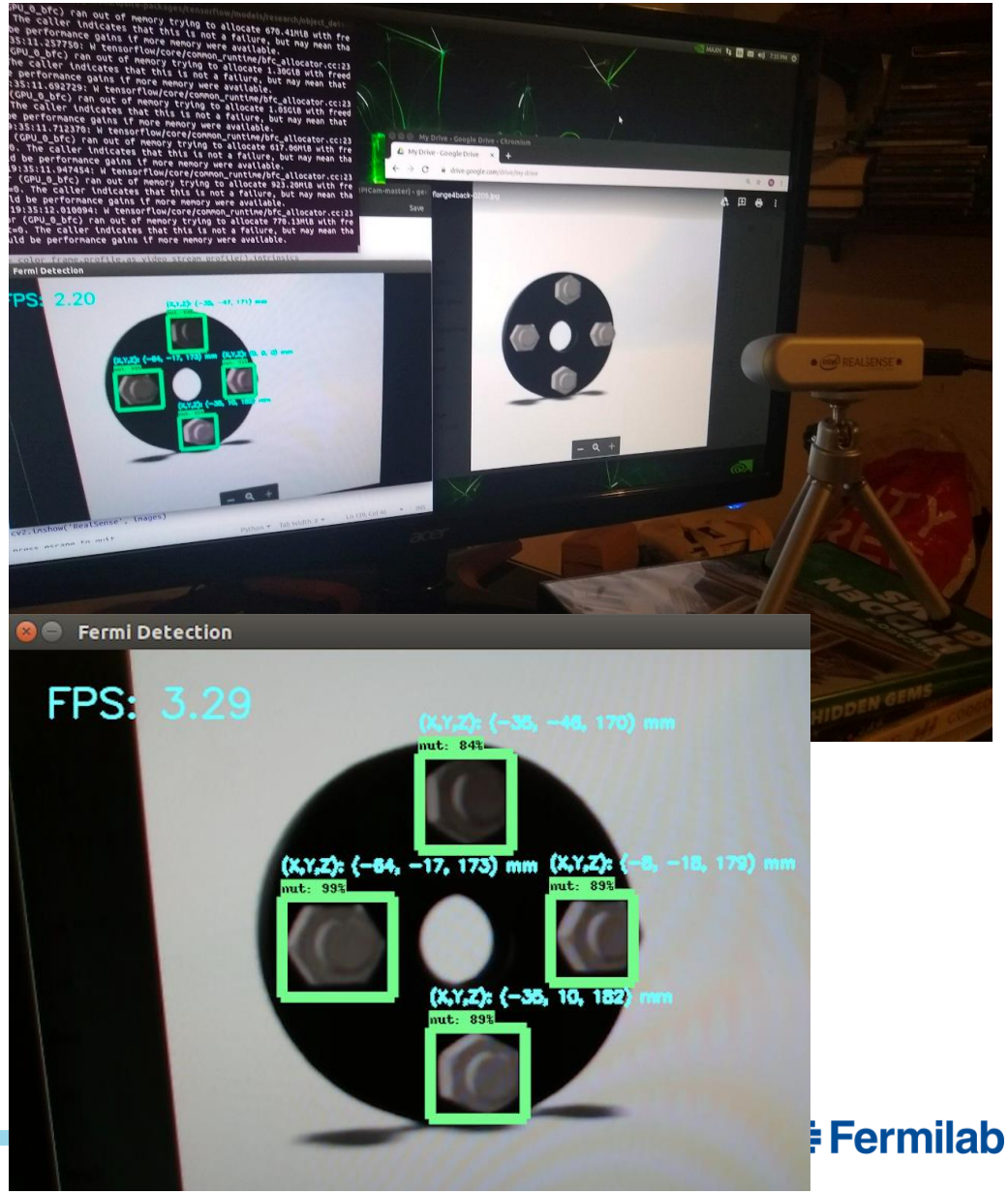
3D Visualization Processor for Accelerator Facility

- Identify objects unique to the accelerator complex
- Train AI by using CAD drawings
- NVIDIA hardware/software integration
- Next step: Develop ROS to process 3D images and manipulate robot arm



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Cutting Edge Technology Investigation

- Fast Focus Lens
- Liquid Lens
- Radiation detectors